Stereo Imaging with (Pico)satellites

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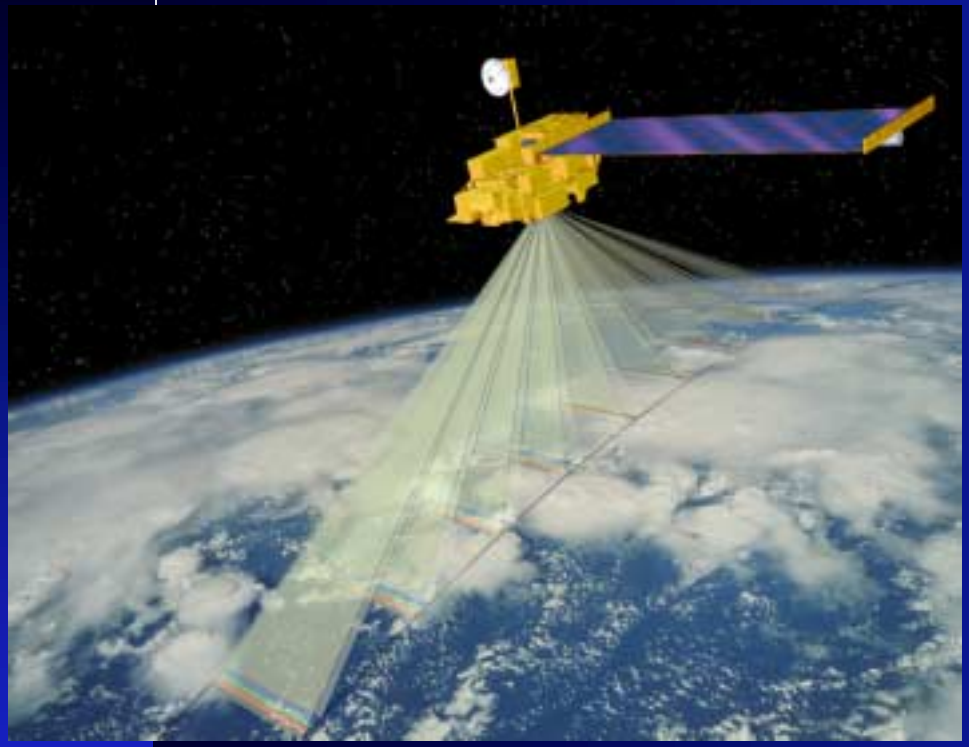
Overview

- Existing technology
  - Push-broom imaging from MISR
  - Cloud imagery
  - Stereo heights and winds
  - Comparison with GOES
- Future ideas
  - Single orbits
    - Hen and chickens
    - Doublets
    - Triplets

MISR: Multiangle Imaging SpectroRadiometer
— pushbroom scanner on Terra satellite
— launched 12/19/99



9 view angles at Earth surface:
70.5º, 60.0º, 45.6º, 26.1º forward
nadir
70.5º, 60.0º, 45.6º, 26.1º backward

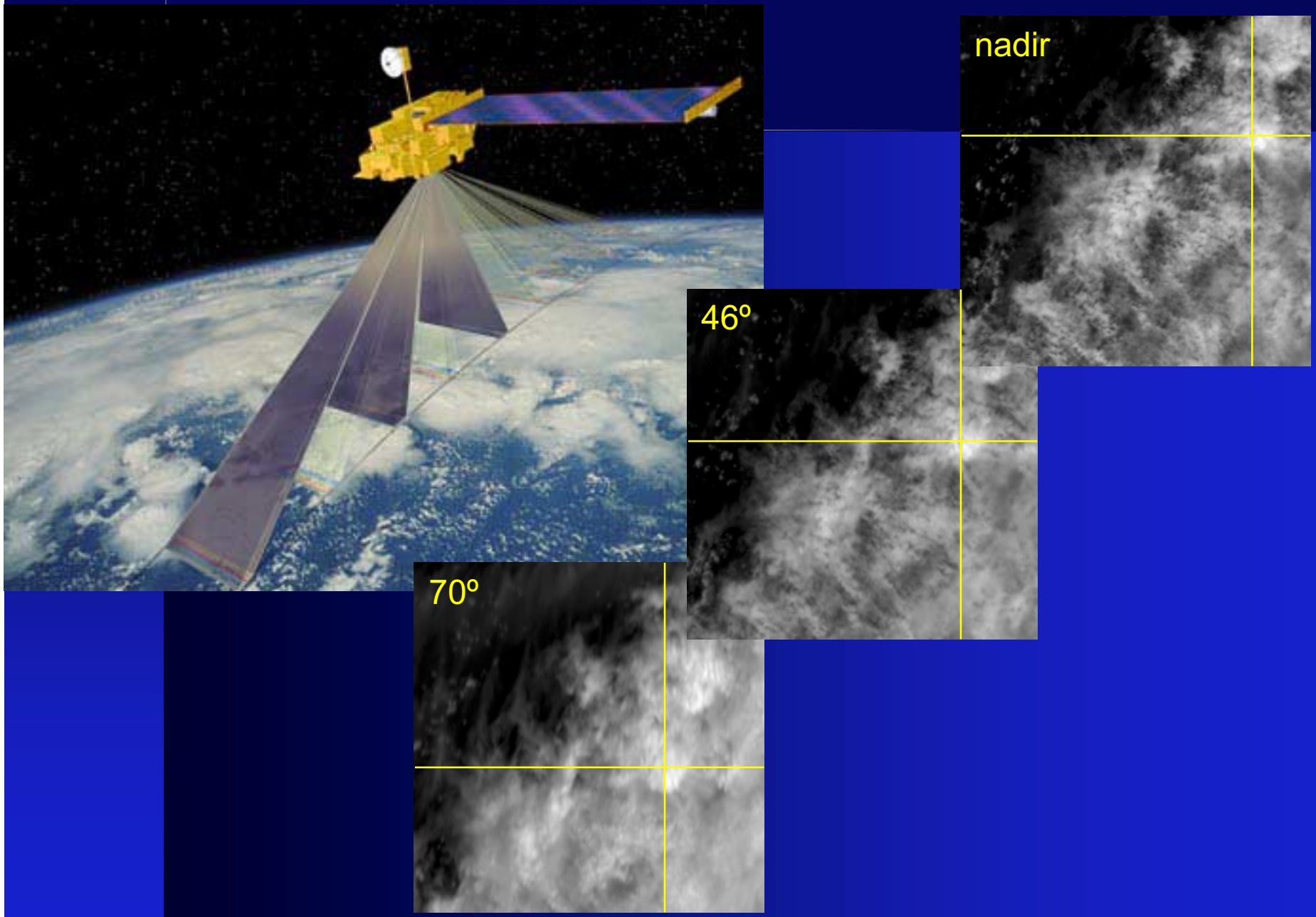
Continuous pole-to-pole coverage on orbit dayside

400-km swath

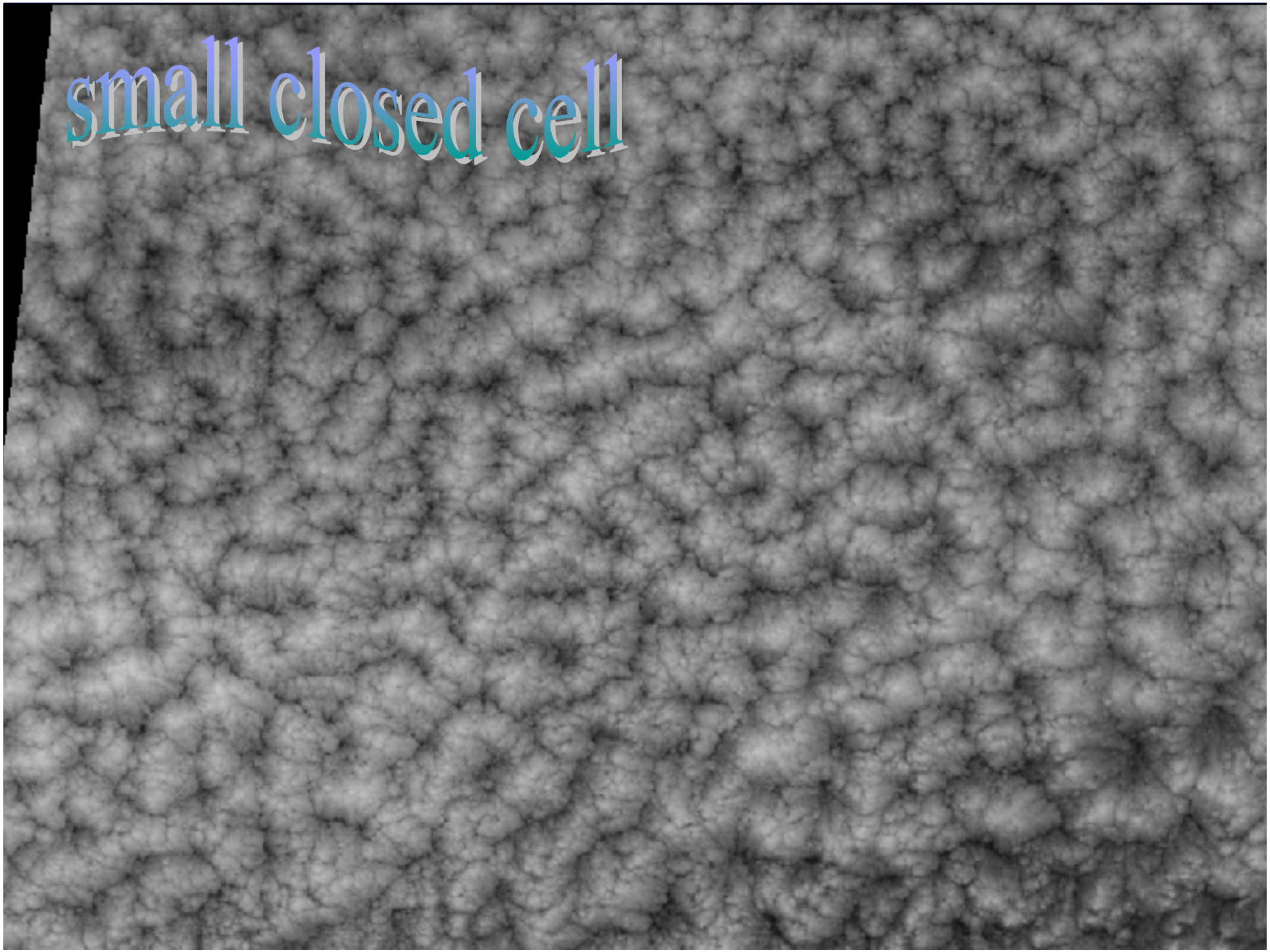
Contiguous zonal coverage:
9 days at equator
2 days at poles

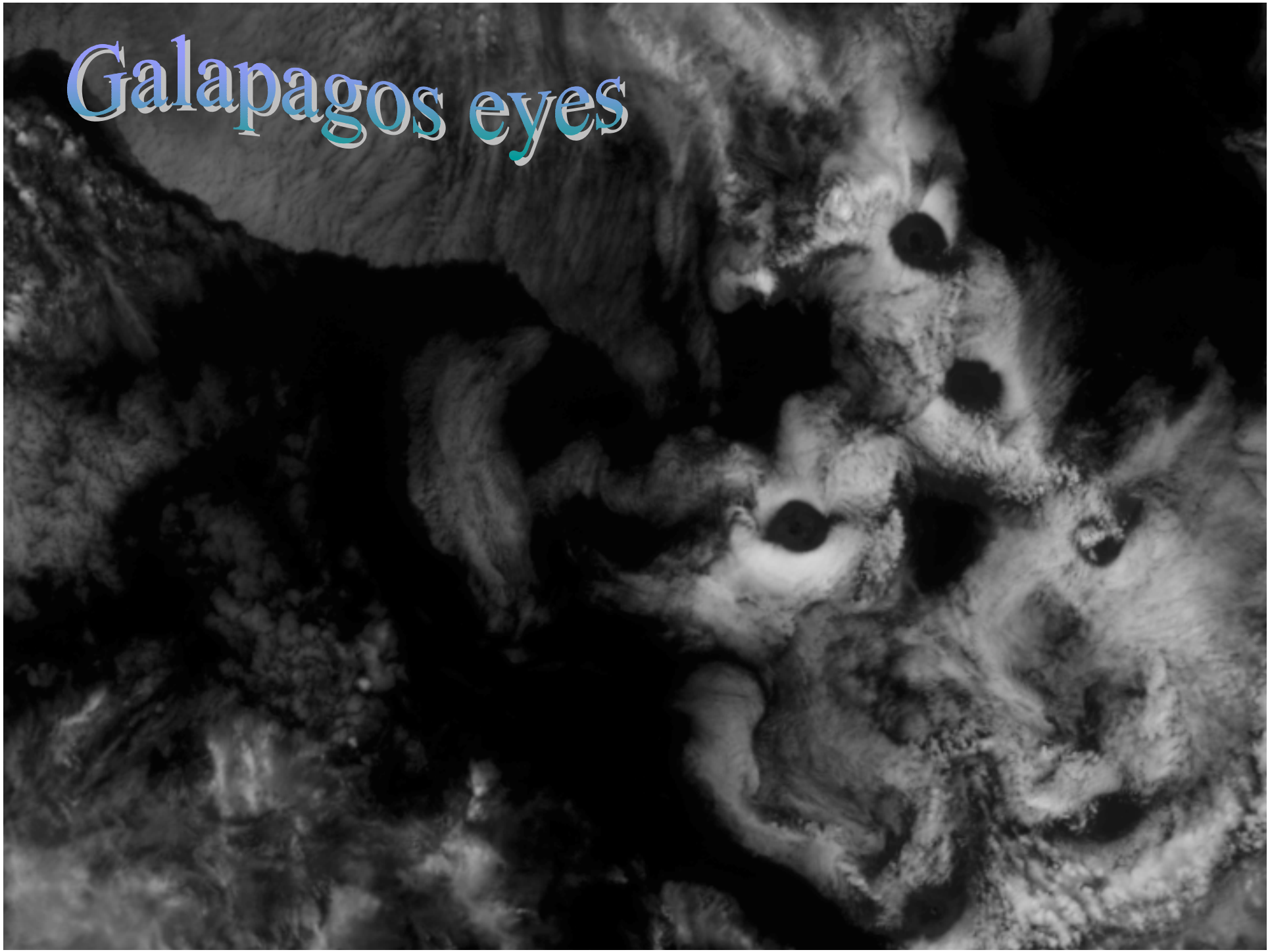
275 m - 1.1 km sampling

7 minutes to observe each scene at all 9 angles

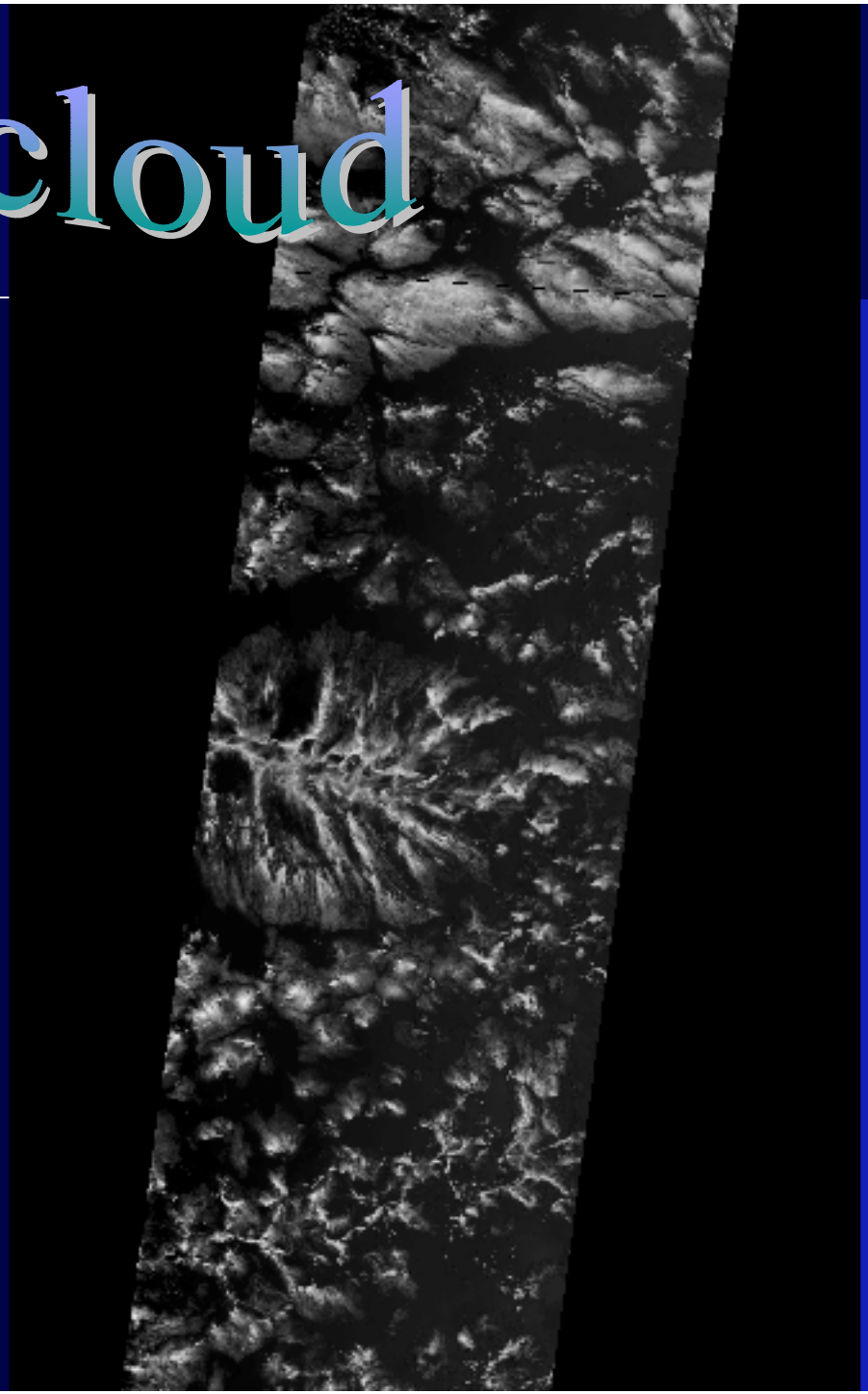

nadir
46º
70º

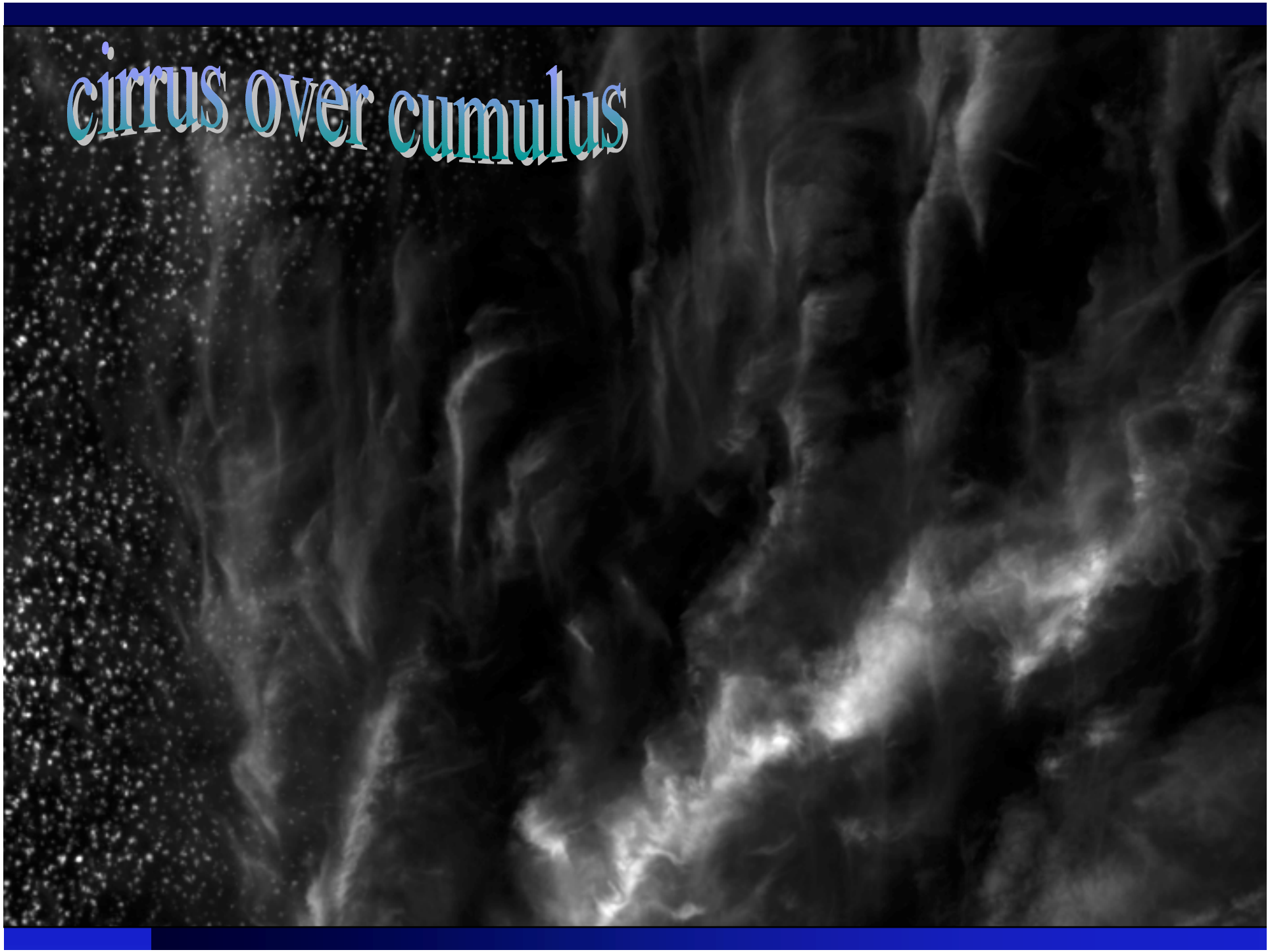

moguls


small closed cell


Galapagos eyes

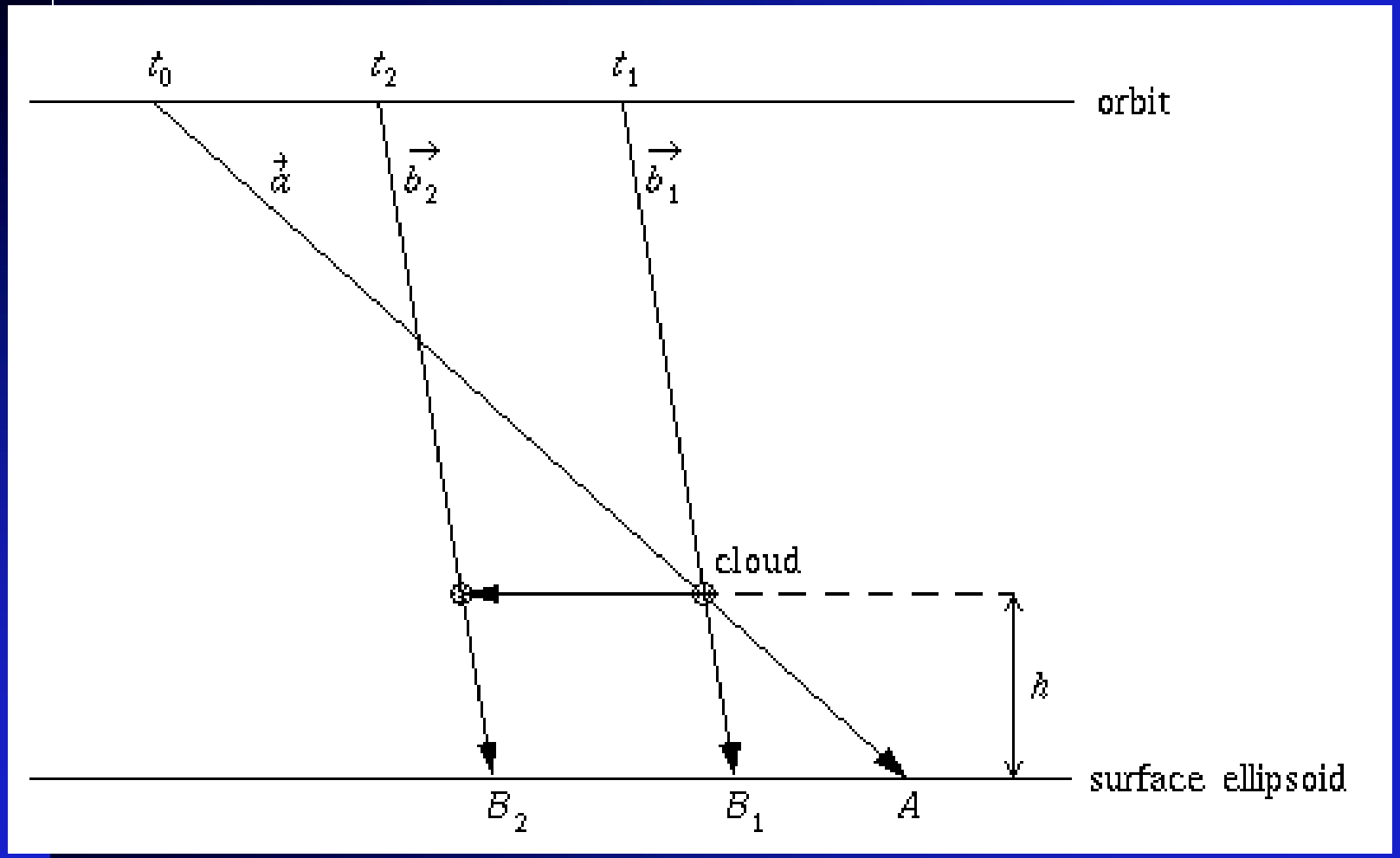
leaf cloud

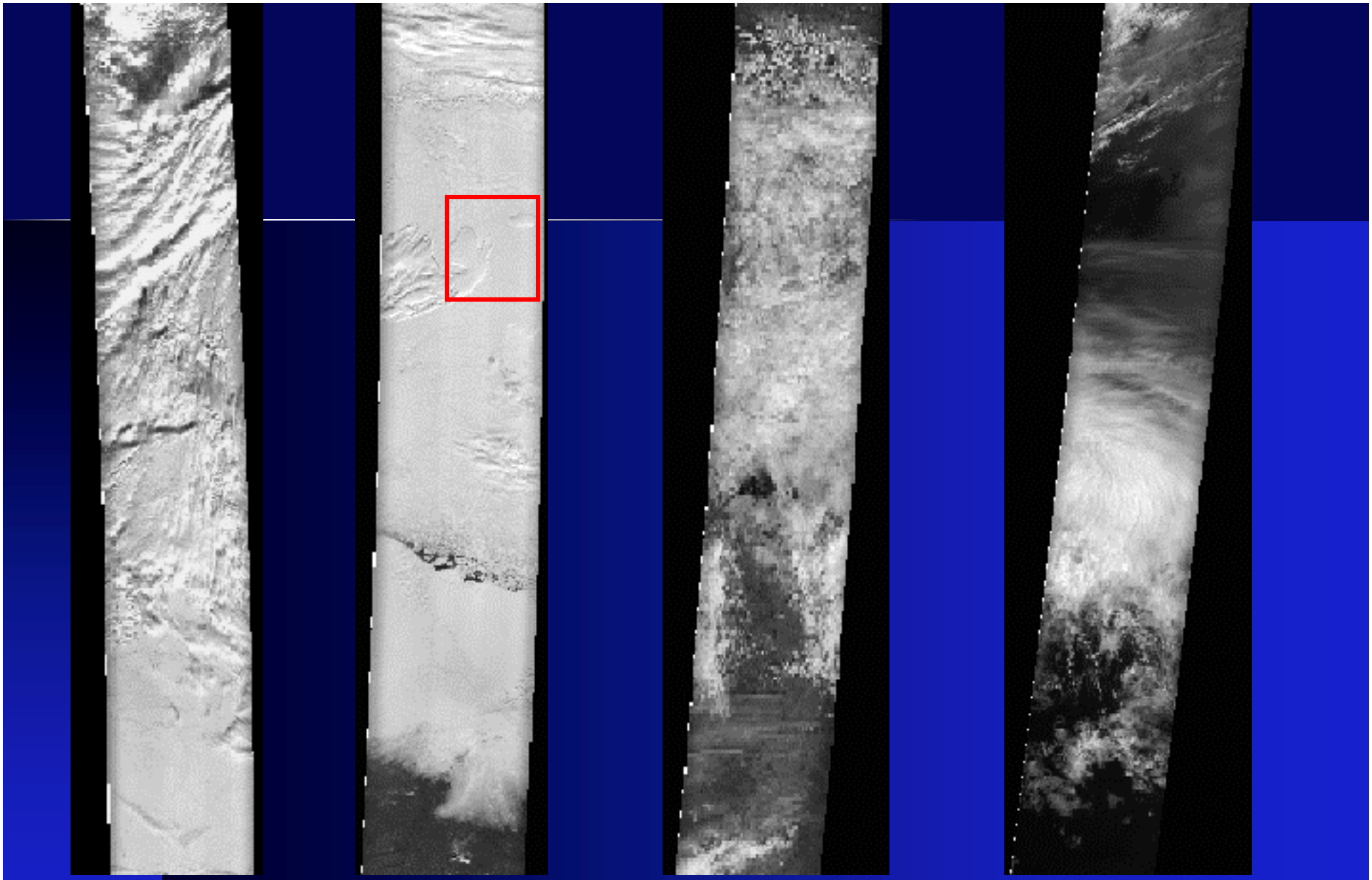



cirrus over cumulus


wind driven Sc (far south)

Outline of the stereo technique

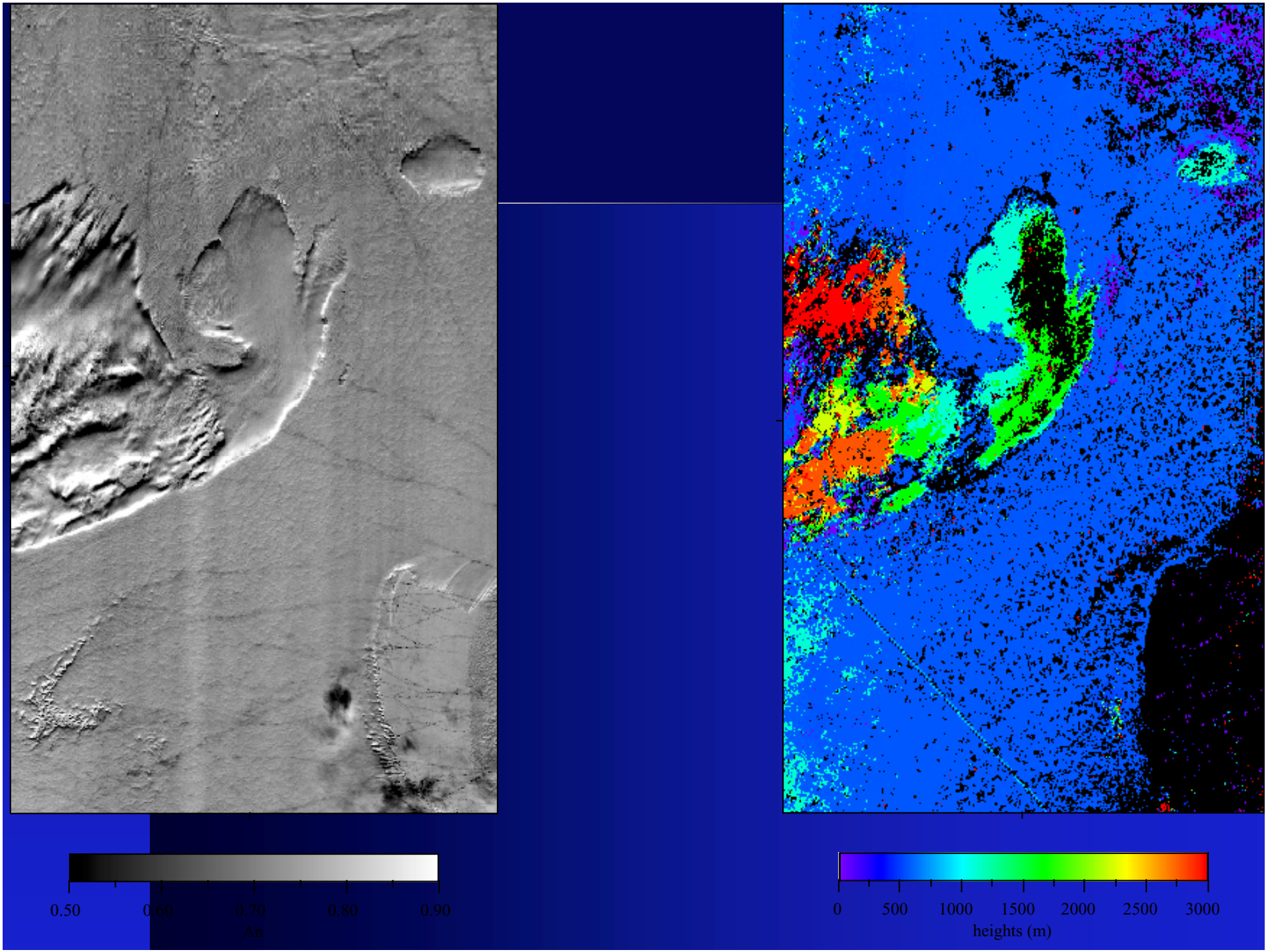


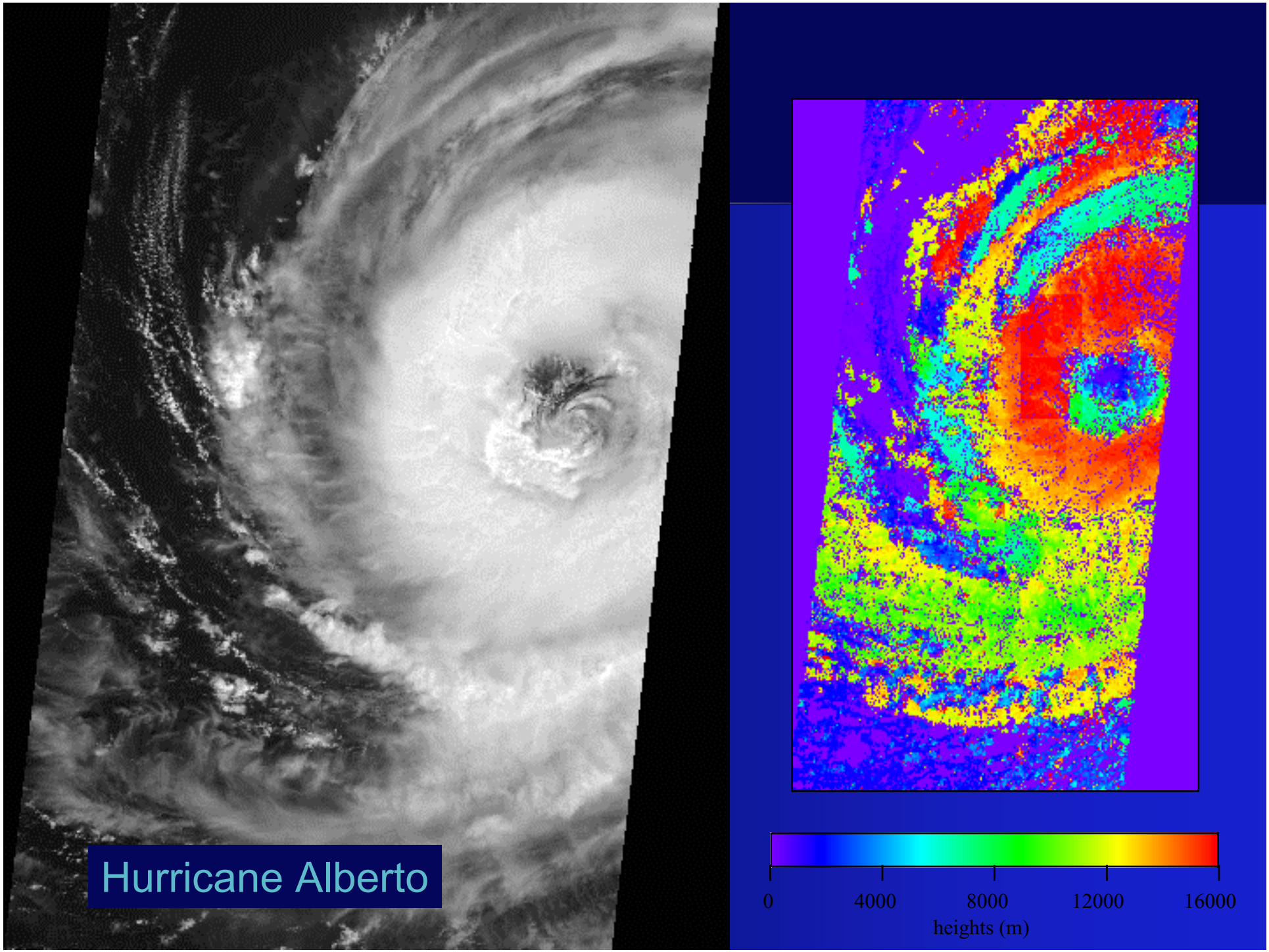


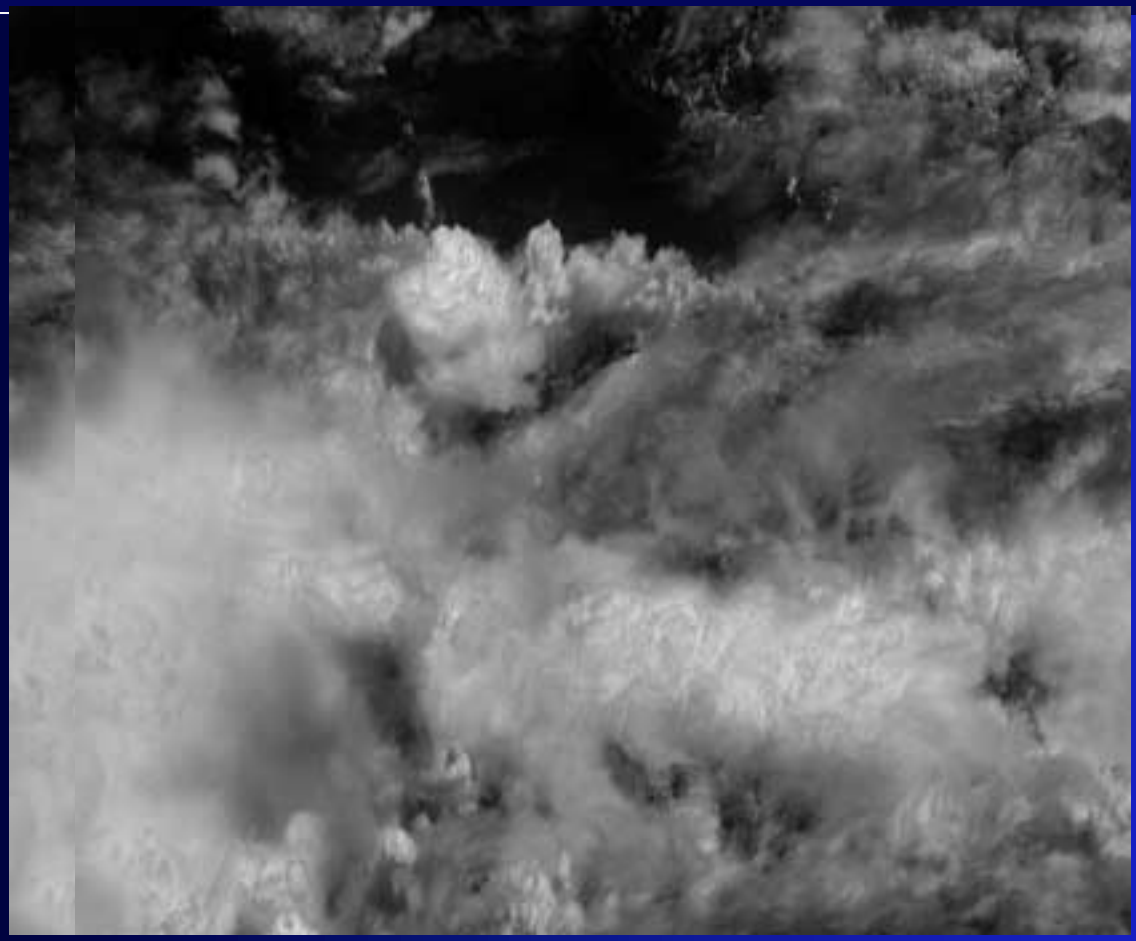
Arctic

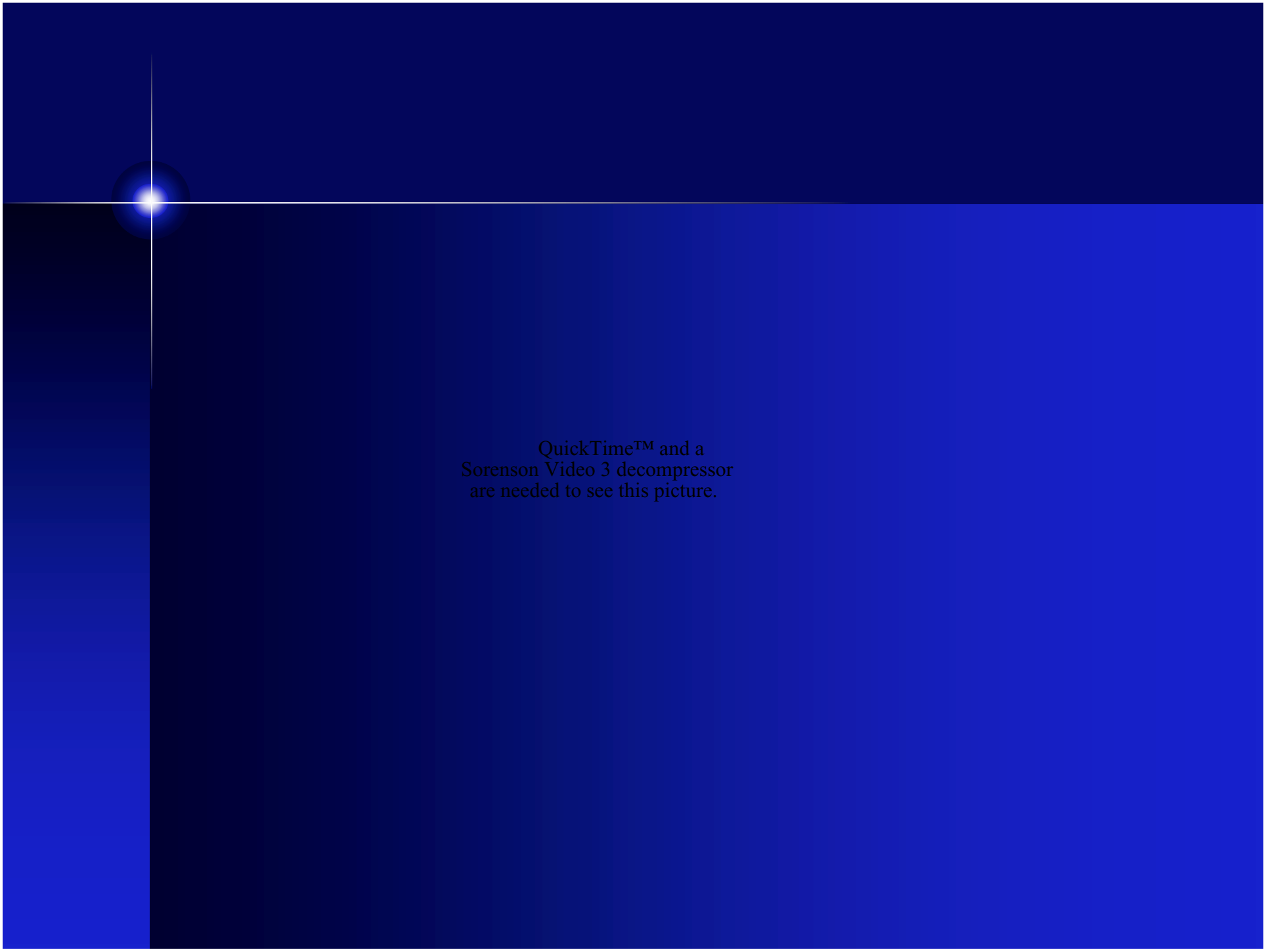
NW Pacific

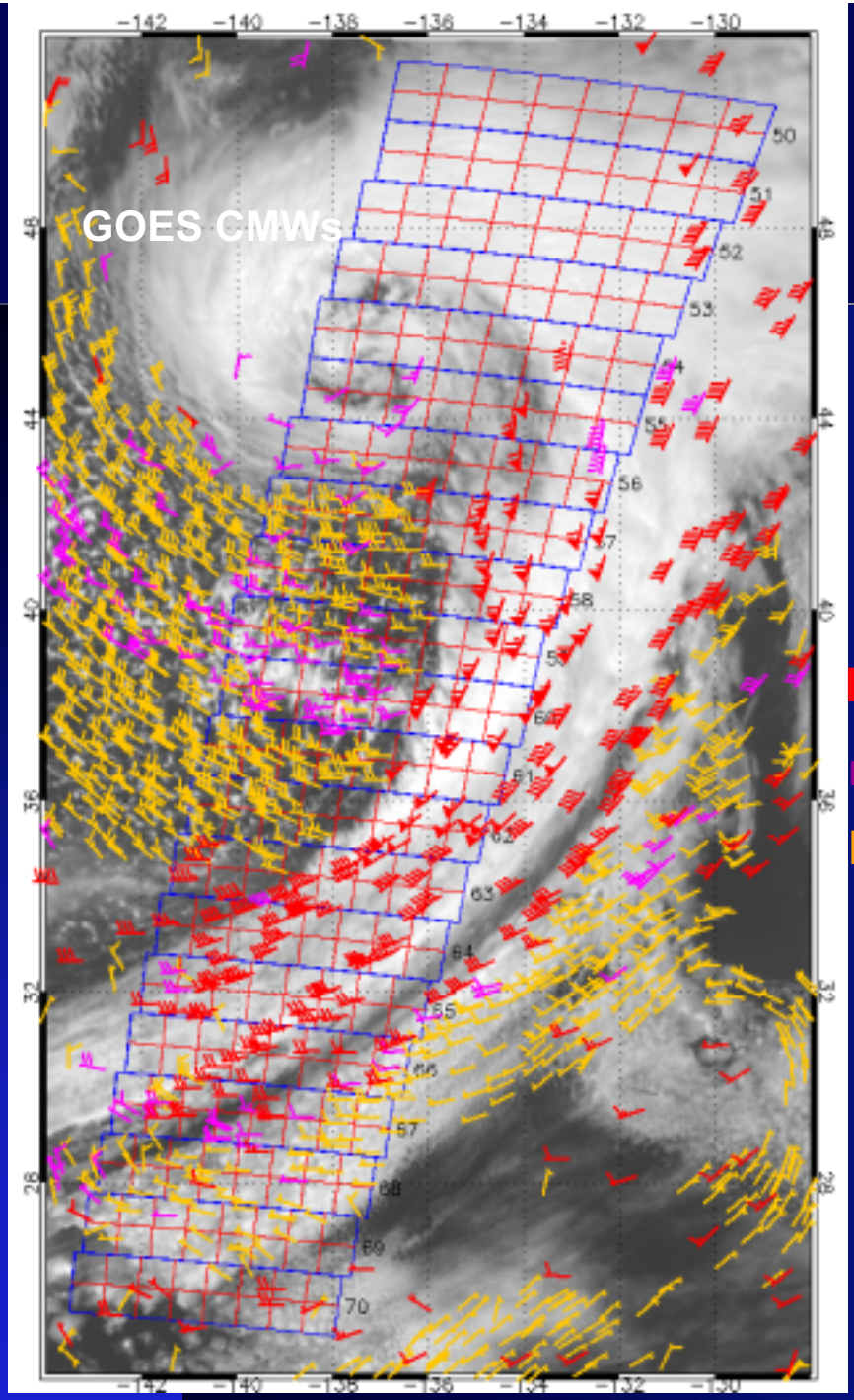
Spectral reflectivity at coarse resolution, from one orbit, first half


0.50
0.60
0.70
0.80
0.90
An
0
500
1000
1500
2000
2500
3000
heights (m)


Hurricane Alberto
0
4000
8000
12000
16000
heights (m)




QuickTime™ and a
Sorenson Video 3 decompressor
are needed to see this picture.

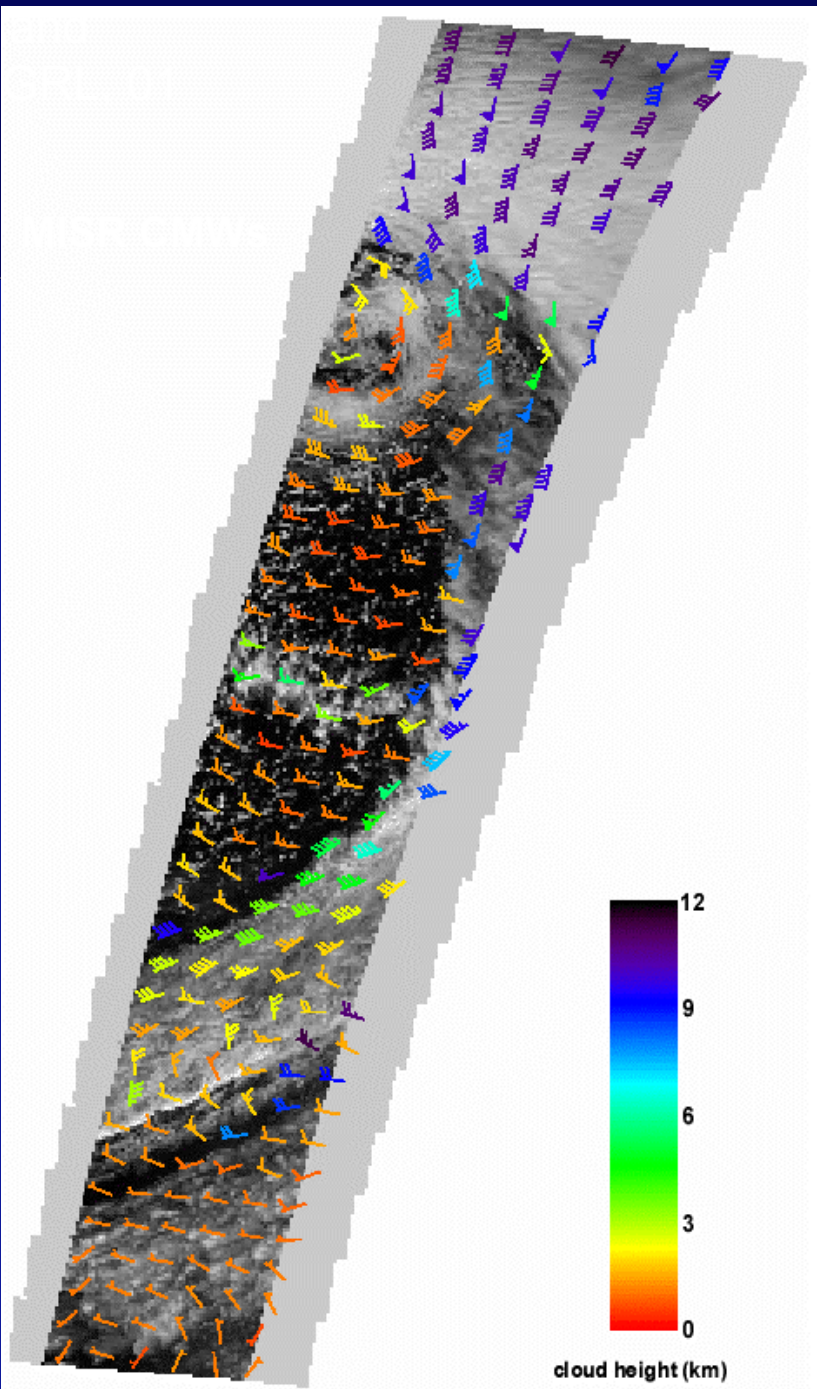


Horváth
Davies,

high

middle

low



Summary of GRL paper

- Automated, simultaneous retrieval of cloud motion and height works.
- Good agreement between GOES and MISR cloud-motion winds.
- ± 3 m/s for wind and ± 400 m for height.

Advantages of a MISR-like approach

- Direct height measurement, no assumptions on atmospheric temperature profile required.
- Available at all latitudes, including poles.
- Quality does not degrade with latitude.
- Results are insensitive to radiometric calibration.
- Input data have high spatial resolution (275 m) and high contrast sensitivity (14 bits).
- Retrievals are feasible over multiple cloud layers.
- Cost effective.

Practical implementation –initial steps

- Confirm impact of winds on NWP
- Ensure real-time data processing
- Trade-off studies for practical operational approaches
  - number of cameras (minimum of 3 required)
  - number of spectral bands (only 1 necessary for winds/heights)
  - calibration approach (in principle, not required)

Single Orbit Ideas

- Hen and Chickens
  - Central satellite with multiangle, multispectral radiometer
  - Two (or more) small satellites, ± 350 km in same orbit, single camera, single spectral band, nadir viewing
- Doublet
  - Two satellites, two cameras each (nadir and 52°) 700 km apart
- Triplet
  - Three satellites, one camera each (+26°, 0°, -26°)